Gold King Mine Water Temporary Water Treatment System
Proposed Effluent Limits

Low pH, high metal content water has discharged from the Gold King Mine since at least 2005. From 2009 through 2014 flows ranged from 22 to 250 gallons per minute (gpm), pH ranged from 2.3 to 5.1, and metal concentrations were as shown in Attachments A1 and A2. Water currently discharges from the mine at 500 to 600 gpm with dissolved metals concentrations similar to those measured before the blowout, but total metal concentrations that are significantly higher (Table 1).

A temporary water treatment plant (WTP) will be used to remove particulates and metal contaminants from the Gold King Mine discharge. The intent of water treatment is to mitigate the effect of the increased contaminant load resulting from the Gold King Mine blowout on August 5, 2015. The treatment system, while temporary, will operate 24 hours per day, year round, and will be located near Gladstone, Colorado. Water discharging from nearby mines will not be treated.

Effluent limits were developed to provide minimum acceptable performance criteria for the WTP (Table 1). The system will be operated at maximum efficiency to provide the greatest reduction in contaminants possible and will not "settle" on these effluent limits if additional contaminant removal is possible.

While effluent limits are typically developed based on an allowable amount of dilution from the receiving water body, Cement Creek at Gladstone has particularly poor water quality due to the presence of many discharging mines in the vicinity. The historic (2009-2014) water quality exceeds Colorado Water Quality Standards (WQS) for Animas River Stream Segment 7 (Cement Creek) for total cadmium, copper, and zinc. The historic water quality may also exceed the implied standards for dissolved cadmium, copper, iron, manganese, and zinc.

Proposed effluent limits for the temporary WTP are based on the greater of two values for each metal:

1. Cement Creek WQS

2. Average historic concentrations (2009-2014) observed at Cement Creek monitoring station CC18, located downstream of the Gold King and several nearby mines including the Mogul, Red and Bonita, and American Tunnel.

These limits were selected for the following reasons:

- The intent is for the WTP to maintain water quality until Gold King Mine discharge returns to previous levels or a long-term remedy is determined and established. An evaluation of long-term water treatment objectives for the local mine discharges may be established at a later time.

- Streamflow has a sharp peak during spring runoff while the mine discharge is more likely to be relatively constant, so the relative contribution of the mine discharge is greatest during low-flow. This results in greater contaminant concentrations in Cement Creek during low flow and lower concentrations during spring runoff when more "dilution" water is available. Average annual concentrations provide a reasonable estimation of water quality in Cement Creek. Selecting low-flow average concentrations or the maximum observed concentration might be considered too lenient. Selecting high-flow average concentrations may set an artificially low limit because during spring runoff the discharge will be diluted, resulting in lower concentrations downstream in Cement Creek as typically occurs.

- WTP inflows will likely have consistent chemistry and the WTP will treat to the maximum possible effectiveness year round, so seasonal criteria were not considered necessary to protect

downstream waters.

- There are no direct WQS for dissolved metals in Cement Creek, but rather a narrative standard allowing: "The concentration of dissolved aluminum, cadmium, copper, iron, lead, manganese, and zinc that is directed toward maintaining and achieving water quality standards established for segments 4a and 4b (both Animas River locations)." Effluent limits for dissolved constituents were added to provide additional protectiveness of the Animas River, but will be considered secondary to the total metals effluent limits.

If water is treated from current Gold King concentrations and flows to the proposed effluent limits, the WTP would remove 0.4 pounds per day (lb/d) cadmium, 34 lb/d copper, and 106 lb/d zinc.

TABLE 1
Concentrations and Proposed Discharge Criteria

	Gold King Mine Post-Blowout Concentration - Average	2009-2014 Overall Average Concentration at CC18	2009-2014 Maximum Concentration at CC18	Cement Creek WQS (ug/L)	4a Acute WQS for Metals noted on Cement Creek WQS*	Proposed Effluent Limits	% Removal to Achieve Proposed Effluent Limits
DISSOLVED METALS							
Aluminum (µg/L)	34,500	5540	9810	*	NS	NS	NA
Cadmium (µg/L)	73.3	18.5	30	*	9.1	18.5	75%
Copper (µg/L)	5630	517	1440	*	49.6	517	91%
Iron (µg/L)	188,000	22,400	39,000	*	3780#	22,400	88%
Lead (µg/L)	46	15	43	*	281	281	None
Manganese (µg/L)	33,800	13,000	24,300	*	4740	13,000	62%
Zinc (µg/L)	23,800	7500	12,900	*	620	7500	68%
TOTAL METALS							
Aluminum (µg/L)	35,000	5900	9640	*	3550	5900	83%
Arsenic (µg/L)	57.4	Not detected	Not detected	100	NS	100	None
Beryllium (µg/L)	10.7	3	3.9	100	NS	100	None
Cadmium (µg/L)	74.3	19	30	10	NS	**19**	74%
Chromium (µg/L)	4.98	Rarely detected	3.1	100	NS	100	None
Copper (µg/L)	5680	529	1400	200	NS	**529**	91%
Iron (µg/L)	190,000	25,400	39,800	NS	NS	25,400	87%
Lead (µg/L)	47.5	29	104	100	NS	100	None
Molybdenum (µg/L)	5.97	NA	NA	160	NS	160	None
Nickel (µg/L)	69.8	21	38.4	200	NS	200	None
Selenium (µg/L)	6.28	2	3.5	20	NS	20	None
Zinc (µg/L)	24,300	7460	12,400	2000	NS	**7460**	69%
pH	3.01	3.69	3.24 (minimum)	3.7 to 9	NS	3.7	NA

Proposed primary effluent limits are shaded; proposed secondary effluent limits unshaded

WQS Water quality standard µg/L micrograms per liter

Iron standard for Segment 4a is a chronic standard.

* Colorado Regulation 34 states that Cement Creek should achieve: "The concentration of dissolved aluminum, cadmium, copper, iron, lead, manganese, and zinc that is directed toward maintaining and achieving water quality standards established for segments 4a and 4b." The Segment 4a standards shown here are the acute standards calculated at average hardness at the Animas River downstream of Silverton (A72) station.

ATTACHMENT A1

Historic Dissolved Metals Concentrations
Gold King Mine (CC06) 2009-2014

	All Data			Runoff			Non-Runoff		
	Average	Min	Max	Average	Min	Max	Average	Min	Max
Aluminum (µg/L)	31,900	7220	60000	43,200	21000	60000	22596	7220	39200
Antimony (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (µg/L)	26.9	ND	160	55.2	ND	160	3.81	ND	8.4
Barium (µg/L)	43.8	25	50	50	50	50	37.5	25	50
Beryllium (µg/L)	8.59	3.7	20	9.39	6.8	20	7.95	3.7	10
Cadmium (µg/L)	72.3	36.1	138	88.9	57.1	138	58.8	36.1	88.6
Calcium (µg/L)	379,000	344,000	414,000	370,000	344,000	403,000	386,000	358,000	414,000
Chromium (µg/L)	6.3	ND	16.5	9.4	4.0	16.5	3.6	ND	5.15
Cobalt (µg/L)	91.3	69.1	121	98.1	75.2	121	84.6	69.1	100
Copper (µg/L)	6380	2450	12,100	8030	3800	12,100	5040	2450	8370
Hardness (mg/L)	1010	997	1040	1010	997	1020	1020	1000	1040
Iron (µg/L)	109,000	46,800	257,000	147,000	46,800	257,000	77,300	47,400	123,000
Lead (µg/L)	15.5	ND	29	18.4	1.81	25.3	13.1	ND	29
Magnesium (µg/L)	26,700	19,500	37,000	30,400	22,100	37,000	23,673	19,500	29,000
Manganese (µg/L)	30,200	26,000	35,300	28,800	26,000	31,800	31,300	26,200	35,300
Nickel (µg/L)	60.4	37.4	94	71.3	39.7	94	51.6	37.4	68.2
Potassium (µg/L)	1758	931	2500	1676	931	2500	1825	1250	2200
Selenium (µg/L)	4.74	1.7	10	6.6	3.4	10	4.2	1.7	5.5
Silver (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium (µg/L)	5380	4680	6140	5160	4680	6050	5560	4760	6140
Strontium (µg/L)	5590	5090	6220	5655	5090	6220	5530	5280	5780
Thallium (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (µg/L)	25,700	13,000	41,900	30,300	19,100	41,900	21,900	13,000	29,300

µg/L micrograms per liter
mg/L milligrams per liter

ATTACHMENT A2
Historic Total Metals Concentrations
Gold King Mine (CC06) 2009-2014

	All			Runoff			Non-Runoff		
	Average	**Min**	**Max**	**Average**	**Min**	**Max**	**Average**	**Min**	**Max**
Aluminum (µg/L)	31,200	7,840	61,600	43,400	21,200	61,600	22,400	7840	36,700
Antimony (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic (µg/L)	30	ND	153	64	ND	153	4	1	13
Barium (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium (µg/L)	7.6	3.6	8.8	7.8	7	8.8	7.4	3.6	9.4
Cadmium (µg/L)	70	38	136	85	56	136	58	38	89
Calcium (µg/L)	374,000	356,000	388,000	378,000	378,000	378,000	372,000	356,000	38,8000
Chromium (µg/L)	5.8	ND	14	9.3	4	14	3.5	ND	9.85
Cobalt (µg/L)	82	72	100	74	74	74	86	72	100
Copper (µg/L)	6480	2430	12,400	8210	3730	12,400	5220	2430	8330
Iron (µg/L)	114,000	50,300	254,000	159,000	50,300	254,000	80,800	54,000	123,000
Lead (µg/L)	16	ND	29	20	15	25	14	ND	29
Magnesium (µg/L)	23,567	21,700	26,800	22,200	22,200	22,200	24,300	21,700	26,800
Manganese (µg/L)	30,674	26,700	36,000	29,200	26,900	32,200	31,800	26,700	36,000
Nickel (µg/L)	59	35	95	73	37	95	49	35	69
Potassium (µg/L)	1720	1250	2500	2500	2500	2500	1330	1250	1410
Selenium (µg/L)	5.3	2	10.4	6.65	4.2	10.4	4.38	2	7.83
Silver (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium (µg/L)	4990	4840	5080	5080	5080	5080	4940	4840	5040
Strontium (µg/L)	5847	5430	6280	6280	6280	6280	5630	5430	5830
Thallium (µg/L)	5.06	ND	5.06	5.06	ND	5.06	5.06	ND	5.06
Vanadium (µg/L)	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc (µg/L)	26,100	14,500	44,700	31,300	19,700	44,700	22,300	14,500	29,700

µg/L micrograms per liter